

07-19-00 A

Case Docket No. PHF 99,563

THE COMMISSIONER OF PATENTS' AND TRADEMARKS, Washington, D.C. 20231

Enclosed for filing is the patent application of Inventor(s):  
LAURENT DEPERISIN

For: COMMUNICATION SYSTEM, RECEIVER, DEVICE AND METHOD OF  
CORRECTING CHANNEL ERRORS

**ENCLOSED ARE:**

- ☒ Appointment of Associates;
- ☒ Information Disclosure Statement, Form PTO-1449 and copies of documents listed therein;
- ☐ Preliminary Amendment;
- ☒ Specification (9 Pages of Specification, Claims, & Abstract);
- ☒ Declaration and Power of Attorney:  
(1 Page of a ☐ fully executed ☒ unsigned Declaration);
- ☒ Drawing (2 sheets of ☐ informal ☒ formal sheets);
- ☒ Certified copy of a FRENCH application Serial No.9909404;
- ☒ Authorization Pursuant to 37 CFR §1.136(a)(3)
- ☐ Other: ;
- ☐ Assignment to

**FEE COMPUTATION**

CLAIMS AS FILED				
FOR	NUMBER FILED	NUMBER EXTRA	RATE	BASIC FEE - \$690.00
Total Claims	9 - 20 =	0	X \$18 =	0.00
Independent Claims	4 - 3 =	1	X \$78 =	78.00
Multiple Dependent Claims, if any			\$260 =	0.00
TOTAL FILING FEE . . . . .			=	\$768.00

Please charge Deposit Account No. 14-1270 in the amount of the total filing fee indicated above, plus any deficiencies. The Commissioner is also hereby authorized to charge any other fees which may be required, except the issue fee, or credit any overpayment to Account No. 14-1270.

☐ Amend the specification by inserting before the first line as a centered heading --Cross Reference to Related Applications--; and insert below that as a new paragraph --This is a continuation-in-part of application Serial No. , filed , which is herein incorporated by reference--.

**CERTIFICATE OF EXPRESS MAILING**

Express Mail Mailing Label No. EL458217948US  
Date of Deposit July 18, 2000  
I hereby certify that this paper and/or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Atty. Docket

LAURENT DEPER SIN

PHF 99,563

Serial No.

Group Art Unit:

Filed: Concurrently

Examiner:

COMMUNICATION SYSTEM, RECEIVER, DEVICE AND METHOD OF CORRECTING  
CHANNEL ERRORS

Honorable Commissioner of Patents and Trademarks  
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Prior to calculating the filing fee and examination,  
please amend the above-identified application as follows:

IN THE SPECIFICATION

Page 1, before line 1, insert as a centered heading  
--BACKGROUND OF THE INVENTION--;  
immediately between the above insertion,  
insert at the left margin: --1. Field  
of the Invention--;  
line 10, which is presently blank, insert at the  
left margin: --2. Description of the  
Related Art--;  
line 14, which is presently blank, insert as a  
centered heading --OBJECT AND SUMMARY OF  
THE INVENTION--.

Page 2, before line 10, which is presently blank, insert as

a centered heading --BRIEF DESCRIPTION OF  
THE DRAWING--;

line 12, change "drawings" to --drawing--.

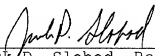
line 16, change "Fig. 2 shows 3" to  
--Figs. 2A, 2B, and 2C show--.

line 23, which is presently blank, insert as a  
centered heading --DETAILED DESCRIPTION OF  
THE PREFERRED EMBODIMENTS--.

REMARKS

The specification has been amended to add headings pursuant to  
37 CFR § 1.77 and to correct the brief description of the drawing.  
Entry of this amendment is respectfully requested.

Respectfully submitted,

By   
\_\_\_\_\_  
Jack D. Slobod, Reg. 26,236  
Attorney for Applicant(s)  
(914) 333-9606

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## Communication system, receiver, device and method of correcting channel errors

The invention relates to a receiver and a communication system for transmitting data frames between a transmitter and a receiver via a communication channel, the receiver comprising an error correction device for correcting transmission errors in the received data.

5           The invention also relates to the error correction device and to a method of correcting transmission errors in received digital data frames.

The invention is widely used in speech communication systems, notably in digital mobile telecommunication systems and voice-transmission systems using the IP (Internet Protocol) or ATM (Asynchronous Transfer Mode) protocol.

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United States patent no. 5,432,778 describes a method of detecting transmission errors in speech frames received by means of techniques using neuronal networks.

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It is an object of the invention to provide means which are less costly and less complex than those described in the above-mentioned document for detecting transmission errors in received data frames at the receiver end, as well as means for correcting them. To this end, it is proposed that the received data frames convey information intended to represent speech elements. The invention thus provides a receiver, a system and a device as described in the opening paragraph and is characterized in that the error correction device comprises:

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- vocal recognition means for recognizing speech elements in the received data frames,
- detection means for detecting corrupted parts in the recognized speech elements,
- synthesis means for synthesizing parts of the speech elements corresponding to the corrupted parts, and

25

- replacement means for replacing said corrupted parts by the synthesized parts in the received data frames.

Irrespective of the type or size of the considered elements, the number of speech elements required for reconstituting all the words of the language is limited. However, this number may be a critical parameter in accordance with the envisaged application,

particularly when the size of the memory and the computing power of the components used for realizing the invention should be limited. In accordance with a preferred embodiment, the invention therefore proposes that the speech elements constituting the received signal are phonemes or diphones, or any other vocal unit allowing a reconstitution of all the speech words by means of a limited number of units. In the majority of languages, for example, speech is constituted by about fifty phonemes.

These and other aspects of the invention are apparent from and will be elucidated, by way of non-limitative example, with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 is a block diagram of the transmission chain of an example of the system comprising a transmitter and a receiver according to the invention, provided with an error correction device.

Fig. 2 shows 3 curves representing the speech signal as a function of time to illustrate the principal steps of a method according to the invention, realized by the error correction device shown in Fig. 1.

Fig. 3 shows an embodiment of the error correction device according to the invention, shown in Fig. 1.

Fig. 4 illustrates an example of the communication system according to the invention, comprising a telephone transmitter and receiver.

Fig. 1 illustrates the transmission and reception chain of an example of the system comprising a transmitter and a receiver according to the invention. The transmitter comprises:

- a source block 11 comprising, for example, a microphone and an A/D converter for picking up an analog speech signal and producing a digital speech signal  $E(t)$  formed of binary data,
- an encoding block 12 intended to encode speech, on the one hand, for reducing the quantity of information to be transmitted through the channel by transmitting encoded symbol sequences  $A(t)$  representing the speech signal  $E(t)$  and for encoding the channel, on the other hand, for reducing the probabilities of transmission errors by introducing redundancy in the transmitted symbol sequences,

- a modulation block 13 for transforming the symbols  $A(t)$  provided by the encoding block 12 into a modulated signal  $U(t)$  to be transmitted through a communication channel 14.

The receiver comprises:

- a demodulation block 15 for demodulating the signal  $\hat{U}(t)$  received from the channel 14 and for obtaining a demodulated signal  $\hat{A}(t)$  comprising channel transmission errors,

- a decoding block 16 for performing the inverse operation of the encoding block 12 and providing binary data  $\hat{E}(t)$  at the output, comprising residual transmission errors which have not been corrected during decoding of the channel and are notably due to interferences in the channel 14 for a radio transmission or are due to poor reception caused by a high noise level in the channel,

- a specific error correction block 17 for correcting the residual transmission errors detected in the decoded signal  $\hat{E}(t)$  and for supplying a corrected output signal  $S(t)$ ,

- an output block 18 comprising, for example, a D/A converter and a loudspeaker/headphone for supplying an analog output signal to the user.

The channel decoding performance realized by the decoding block 16 depends on the transmission conditions and on a parameter: the length of constraint corresponding to the maximum number of corrupted consecutive bits which the channel decoder can correct. For example, in a low-noise channel, the data suffer from few channel transmission errors. A small constraint length is thus sufficient to obtain very good results at the channel decoding level. In contrast, in a high-noise channel, the data need more redundancy, i.e. a larger constraint length so as to ensure a good probability of recognition during decoding. The redundancy has, however, the major drawback that the quantity of information to be transmitted is increased, which is disadvantageous when the channel has a limited passband.

Therefore, the invention provides the addition of a specific correction block 17 after the decoding block 16 for detecting and correcting the residual channel errors exceeding the correction capacity of the channel decoder without increasing its constraint length. It is thus particularly advantageous in systems which may be subjected to very poor transmission conditions such as radio interference or any other noise phenomenon in the channel.

An error correction method according to the invention, performed, for example, by the correction block 17 is illustrated in Figs. 2A, 2B and 2C. The Figures represent, as a function of time, the digital speech signal  $E(t)$  to be transmitted (Fig. 2A), the corrupted speech signal  $\hat{E}(t)$  supplied to the error correction block 17 by the decoding block 16 (Fig. 2B) and the corrected speech signal  $S(t)$  at the output of the error correction block 17 (Fig. 2C).

In accordance with a fundamental principle of the invention, the signal  $\hat{E}(t)$  supplied by the decoder 16 is a speech signal constituted by a limited number of determined speech elements. Starting from this strong hypothesis, the invention provides the use of a dictionary constituted by speech elements which are suitable for reconstituting all the words of the vocal language, and vocal recognition means for permanently recognizing the elements of the dictionary in the received signal during reception. In accordance with a preferred embodiment, a phoneme dictionary is used for effecting the vocal recognition and allowing restoration of the erroneous data frames up to a duration of 40 ms, which is shorter than the duration of the smallest phoneme of, for example, the English language (approximately 50 ms), the majority of phonemes having a size varying between about 80 and 130 ms.

The method according to the invention for correcting transmission errors in the received digital data frames constituting the corrupted signal  $\hat{E}(t)$  comprises the following steps:

- a vocal recognition step for permanently recognizing speech elements in the received data frames,
- a detection step for detecting corrupted parts in the recognized speech elements,
- a synthesis step for synthesizing parts of the speech elements corresponding to the corrupted parts, and
- a replacement step for replacing said corrupted parts by the synthesized parts in the data frame.

In accordance with the diagram of Fig. 1 comprising the decoding block 16, the detection step is already partially effected during channel decoding realized by the decoder 16 which detects errors in the signal  $\hat{A}(t)$  at the output of the demodulator. This detection is realized by means of conventional error detection methods such as, for example, a method without a memory effect referred to as CRC (Cyclic Redundance Check) which provides an indicator of the corrupted frame, or BFI (Bad Frame Indicator), or a method with a memory effect using a convolution code and a Viterbi detector. As described above, these methods can be carried out to a certain degree of corruption of the speech signal. Beyond this, the use of error correctors 17 will be very interesting for correcting the residual errors left by the conventional channel decoder. In accordance with a variant of an embodiment of the invention, an original complementary detection method may be used as a complement to the conventional specific detection means used by the decoder 16. It concerns the use of the result of the vocal recognition during the step of recognizing and synchronizing the signal  $\hat{E}(t)$  with respect to the elements of the speech dictionary for simultaneously detecting errors

in the recognized speech elements. To this end, the invention directly uses the information supplied by the score of the vocal recognition which indicates a probability of recognizing the current element among the elements of the dictionary. Above a first fixed recognition threshold, for example, between 80% and 100%, the element is considered to be recognized without a necessary correction. Below a second fixed recognition threshold (smaller than the first threshold), of the order of, for example, 10% to 20%, the element is considered to be not recognized without a possibility of correction. Between the two thresholds, the recognition score is used to also indicate a residual error rate to be corrected.

The result of the vocal recognition and error detection steps is illustrated in Fig. 2B. The speech element accentuated by horizontal braces 21 is recognized among the elements of the dictionary during the vocal recognition step permanently effecting the recognition of the data frames during their reception by comparison with all the parallel elements of the dictionary. For a hypothesis required to comprehend the Figure, the start and the end of the element 21 are perfectly synchronized with a given element of the dictionary. An erroneous part accentuated by a double horizontal arrow 22 of the speech element 21 is detected in accordance with the above-described detection methods.

The result of the synthesis and replacement steps is illustrated in Fig. 2C. The part of the recognized speech element 21 accentuated by a double horizontal arrow 23 and corresponding to the erroneous part 22 is synthesized on the basis of information contained in the dictionary for replacing the erroneous part 22 in the element 21 of the frame of received data.

Fig. 3 is a block diagram representing the principal functions of the error correction device according to the invention. The input of the device receives the corrupted speech signal  $\hat{E}(t)$  supplied, for example, by the decoder 16 shown in Fig. 1 so as to supply, at the output, a corrected speech signal  $S(t)$  to a loudspeaker. It comprises:

- a storage memory TM for storing the information of the dictionary of speech elements, this information being constituted by characteristics allowing identification and synthesis of each speech element,
- a recognition processor RP for example of the kind described in application No. EP 0 788 648-A1 for receiving the signal  $\hat{E}(t)$  and for permanently recognizing the speech elements of the dictionary,
- a control device of the signal processor type DSP for receiving, from the processor RP and/or a specific exterior error detector, information about the quality of the current frame  $\hat{E}(t)$  so as to determine whether it comprises transmission errors,



- a synthesis processor SP for realizing the synthesis, under the control of the control device DSP and by means of information about the reference element contained in the memory TM, of the part of the reference element corresponding to the erroneous part, and for replacing the erroneous part by the synthesized part in the received data frame  $\hat{E}(t)$  so as to obtain a corrected output signal  $S(t)$ ,
- a D/A converter D/A for converting the digital output signal  $S(t)$  supplied by the processor SP into an analog signal for a loudspeaker.

In accordance with the method chosen for detecting errors in the recognized speech element, two variants are possible. In accordance with the first method, the control device DSP receives only the information concerning the recognized dictionary element from the processor RP, on the one hand, and a bad frame indicator BFI from a specific exterior detection device, on the other hand, which indicator originates from the channel decoding step realized by the decoder 16. In accordance with the complementary method, it also receives, from the processor RP, an indication of the error deduced from the vocal recognition score.

Fig. 4 illustrates an example of the communication system according to the invention for transmitting data frames between at least one transmitter 41 and at least one receiver 42 via a communication channel 43. In the embodiment of Fig. 4, the transmitter 41 is a base station of a mobile radio telephone system, and the receiver 42 is a cellular telephone. The base station of the telephone comprises a transmission chain and a reception chain, respectively, of the cell type shown in Fig. 1. As a function of the type of communication, notably bidirectional, the transmitters and receivers may be inverted when, for example, the telephone transmits a message for the base station.

The invention is also applicable to many other systems comprising other types of transmitters and receivers such as vocal communication systems on the Internet using computers as transmitters/receivers provided with a voice transmission protocol layer like VOIP (Voice over IP) or VOATM (Voice over ATM).

A system comprising a transmitter and a receiver, an error correction device and an economical and relatively easy method of detecting and correcting channel transmission errors exceeding the correction capacity of the channel decoder have thus been described and illustrated by way of example. It should be noted that numerous variants of the described embodiments are possible without departing from the scope of the invention.

## CLAIMS:

1. A receiver for receiving data frames transmitted through a communication channel and comprising an error correction device for correcting transmission errors in the received data,

characterized in that said error correction device comprises:

- 5 - vocal recognition means for recognizing speech elements in the received data frames,  
- detection means for detecting corrupted parts in the recognized speech elements,  
- synthesis means for synthesizing parts of the speech elements corresponding to the corrupted parts, and  
- replacement means for replacing said corrupted parts by the synthesized parts in the  
10 received data frames.

2. A receiver as claimed in claim 1, characterized in that said speech elements are phonemes or diphones.

15 3. A receiver as claimed in claim 1, characterized in that the error correction device comprises storage means for storing information associated with the speech elements intended to be used by the vocal recognition means and the synthesis means.

4. Telephone equipment comprising a receiver as claimed in claim 1.

20 5. An error correction device for correcting transmission errors in received digital data frames,  
characterized in that it comprises:

- 25 - vocal recognition means for recognizing speech elements in the received data frames,  
- detection means for detecting corrupted parts in the recognized speech elements,  
- synthesis means for synthesizing parts of the speech elements corresponding to the corrupted parts, and  
- replacement means for replacing said corrupted parts by the synthesized parts in the received data frames.

6. A communication system for transmitting data frames between a transmitter and a receiver via a communication channel, the receiver comprising an error correction device for correcting transmission errors in the received data,

5 characterized in that said error correction device comprises:

- vocal recognition means for recognizing speech elements in the received data frames,
- detection means for detecting corrupted parts in the recognized speech elements,
- synthesis means for synthesizing parts of the speech elements corresponding to the corrupted parts, and

10 - replacement means for replacing said corrupted parts by the synthesized parts in the received data frames.

7. An error correction method for correcting transmission errors in received digital data frames,

15 characterized in that it comprises the following steps:

- a vocal recognition step for permanently recognizing speech elements in the received data frames,
- a detection step for detecting corrupted parts in the recognized speech elements,
- a synthesis step for synthesizing parts of the speech elements corresponding to the

20 corrupted parts, and

- a replacement step for replacing said corrupted parts by the synthesized parts in the data frame.

## ABSTRACT:

The invention proposes to improve the performance of the conventional methods of correcting channel transmission errors without increasing the redundancy of encoding the channel. It is particularly advantageous for the systems which may be subjected to very poor transmission conditions such as radio interference or any other noise phenomenon in the channel. The invention provides the addition of a specific correction device after decoding the channel for detecting and correcting the residual channel errors exceeding the correction capacity of the channel decoder. It also proposes that the signal supplied by the decoder is a speech signal constituted by a limited number of determined speech elements. The invention provides permanent vocal recognition of the received signal with the aid of a dictionary of speech elements for detecting the transmission errors and for correcting them by replacing the erroneous part in the received signal by a synthesized part on the basis of the speech dictionary.

Application: Mobile telephony, Voice over Internet/ATM, etc.

Reference: Fig. 1

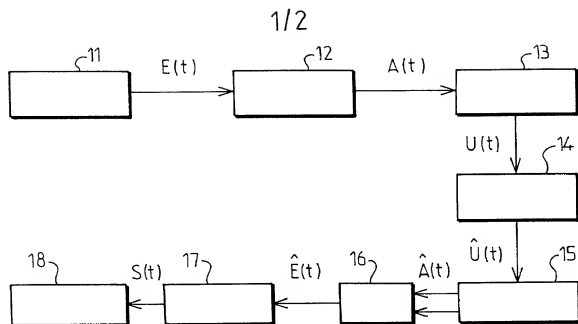
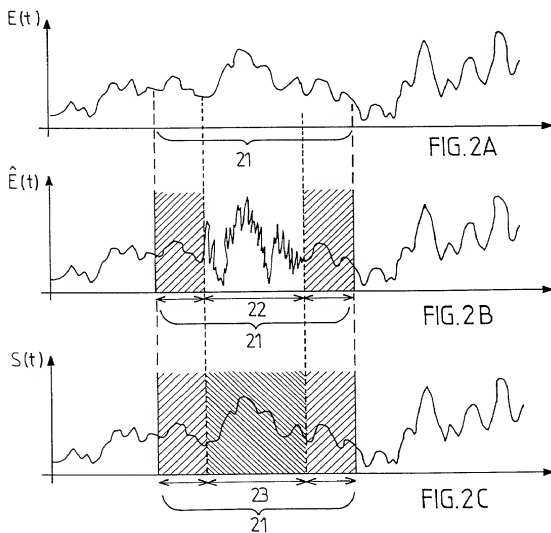


FIG.1



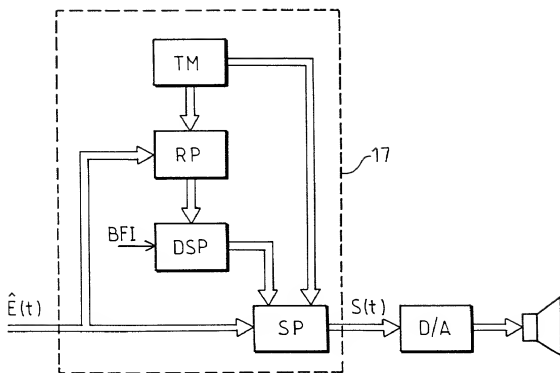


FIG. 3

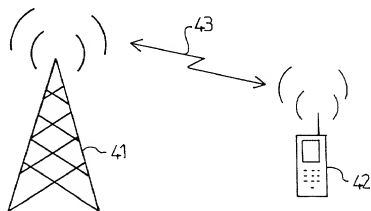


FIG. 4

# DECLARATION and POWER OF ATTORNEY

ATTORNEY'S DOCKET NO.:  
**PHF 99.563**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled  
**"Communication system, receiver, device and method of correcting channel errors"**  
the specification of which (check one)

☐ is attached hereto.

☐ was filed on \_\_\_\_\_ as Application Serial No. \_\_\_\_\_ and was amended on \_\_\_\_\_ (if

applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by the amendment(s) referred to above.

I acknowledge the duty to disclose information which is material to patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

## PRIOR FOREIGN APPLICATION(S)

COUNTRY	APP. NUMBER	DATE OF FILING (DATE, MONTH, YEAR)	PRIORITY CLAIMED UNDER 35 U.S.C. 119
France	9909404	20 July 1999	YES

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35 United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

## PRIOR UNITED STATES APPLICATION(S)

APPLICATION SERIAL NUMBER	FILING DATE	STATUS (PATENTED, PENDING, ABANDONED)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

Algy Tamoshunas, Reg. No. 27,677

Jack E. Haken, Reg. No. 26,902

SEND CORRESPONDENCE TO: Corporate Patent Counsel; U.S. Philips Corporation; 580 white Plains Road; Tarrytown, NY 10591	DIRECT TELEPHONE CALLS TO: (name and telephone No.) (914) 332-0222
--	--

Dated: \_\_\_\_\_ Inventor's Signature: \_\_\_\_\_

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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LAURENT DEPERSIN

PHF 99,563

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Examiner:

Title: COMMUNICATION, SYSTEM, RECEIVER, DEVICE AND METHOD OF  
CORRECTING CHANNEL ERRORS

Honorable Commissioner of Patents and Trademarks  
Washington, D.C. 20231

APPOINTMENT OF ASSOCIATES

Sir:

The undersigned Attorney of Record hereby revokes all  
prior appointments (if any) of Associate Attorney(s) or Agent(s) in  
the above-captioned case and appoints:

**JACK D. SLOBOD**

(Registration No. 26,236) and

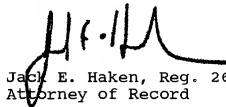
**DICRAN HALAJIAN**

(Registration No. 39,703)

c/o U.S. PHILIPS CORPORATION, Intellectual Property Department, 580  
White Plains Road, Tarrytown, New York 10591, his Associate  
Attorney(s)/Agent(s) with all the usual powers to prosecute the  
above-identified application and any division or continuation  
thereof, to make alterations and amendments therein, and to  
transact all business in the Patent and Trademark Office connected  
therewith.

ALL CORRESPONDENCE CONCERNING THIS APPLICATION AND THE  
LETTERS PATENT WHEN GRANTED SHOULD BE ADDRESSED TO THE UNDERSIGNED  
ATTORNEY OF RECORD.

Respectfully,



Jack E. Haken, Reg. 26,902  
Attorney of Record

Dated at Tarrytown, New York  
this 16<sup>th</sup> day of July, 2000.